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THE BIOLOGY OF COFFEE BERRY BORER *HYPOTHENEMUS HAMPEI* (FERR.) (SCOLYTIDAE, COLOEPTERA) AND ITS INCIDENCE IN THE SOUTHERN TAGALOG PROVINCES[1]

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The life history, habits, color and varietal preference, alternate hosts and seasonal abundance of *Hypothenemus hampei* (Ferr.) and its incidence in S.T.P. from 1975 to 1978 were investigated. The life cycle of *H. hampei* in coffee beans ranged from 66 to 86 days with two larval instars. Developmental period and longevity were shorter among males than females. The pest was relatively most abundant from September to November in Laguna; November to January in Batangas; January in Cavite; and February in Quezon. Robusta (*Coffea canephora*) and Excelsa (*C. excelsa*) were more preferrably attacked by *Hypothenemus* than *C. liberica* and *C. arabica*. Among the 22 plants collected, *Leucaeana leucocephala*, *Glericidia sepium*, *Psychotia luzonensis*, *Phaseolus lunatus* and *Dioscrea luzonensis* were found to support the development of *Hypothenemus*.

Infestation was very high in Batangas, Laguna and Quezon in 1975 to 1977 ranging from 40 to 89% which was considerably reduced in 1978 to not more than 23% except in San Jose, Batangas.

The coffee berry borer, *Hypothenemus hampei* (Ferr.) has long been recognized in most coffee producing countries of the world as one of the notorious pests in coffee plantations. This small beetle had caused incalculable losses in various Central African countries where it is endemic and in countries to which it has been introduced at the beginning of the 20th century notably Malaysia, Ceylon, India and Indonesia.

The first outbreak of the coffee berry borer in the Philippines occurred in June 3, 1963 in Palomok, Cotabato where Robusta coffee was totally lostdue to severe infestation. Manalo (1966) reported that the pest was probably introduced from Indonesia through smuggled coffee beans in Sarangani or Balut Island. Or it must have been carried through the various importations of coffee seeds intended for planting. Since then, the insect must have existed in some plantations as an insignificant pest but increased in numbers through the years due to some favorable conditions.

Total infestation was reported in Tupi, Cotabato while varying degrees of infestation was observed in Davao (Boncato & Gandia 1964). The pest became so destructive that on February 26, 1965, coffee processors, traders,

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growers and BPI officials petitioned the government to issue an administrative order declaring the coffee berry borer as a dangerous pest, providing for its control by placing under quarantine all provinces affected by the insect. By the time the administrative order was approved and implemented, the pest had already spread in Bukidnon and Misamis Oriental (Manalo 1986). The quarantine was quite efficient that the insect was not reported in other places until February 1973, when news of the infestation spread in the Southern Tagalog provinces. The outbreak which was first observed in Laguna and Batangas showed a 88-97% infestation of coffee trees (Morallo-Rejesus & Flores 1973) which necessitated this study on the biology of the coffee berry borer and its incidence.

MATERIALS AND METHODS

A. Biology

Life History and Habits — Adults were collected from field damaged coffee berries and allowed to lay eggs on new berries. A week later the berries were dissected and the eggs were transferred to petri dishes lined with filter paper until hatching. Fifty newly hatched larvae were reared individually in vials provided with fresh coffee berries for food. The cultures were observed daily. The incubation, period, larval instar, pupal and adult stadia, male and female ratio, egg laying habits, fecundity and feeding habits were noted. Three trials were conducted.

Seasonal Abundance — Monthly sampling of 200 berries per tree from at least ten to twenty trees were collected at random per site. Collections were made in Los Banos, Forestry Campus, Jamboree Site, Tuntungin, Kapatagan in Laguna; Tranca, Bay in Laguna; Lipa, Bulaklakan, Pinagtungulan and Mataas na Kahoy in Batangas. Only one farmer's field for each site was used for the collection.

The berries were examined for coffee berry borer damage in the laboratory and some of these berries were kept in cages for emergence of parasites and predators.

Color preference — Black, red, orange and green colored papers representing the different stages of maturation of coffee berries from initial fruiting to storage were placed in a fan-shaped olfactometer with five divisions. The natural color, white, was used as control in the experiment. Each of the colors was distributed and neatly fastened in each of the division of the multichoice olfactometer. Twenty adults were released at the point source and observations were noted every 5 minutes for half an hour.

Varietal Preference — Periodic sampling of 200 mature berries per variety were collected at random from 20 trees per variety in one location each in Tiaong and Lipa City to determine the varietal preference of the

pest. The number of damaged and undamaged berries, and number of larvae, pupae and adult insects were counted.

Alternate Host — Pods of plant species belonging to the genera of coffee and other plants that were adjacent to the coffee plantations in Bay, Laguna; in Lipa Batangas; in Tiaong, Quezon and Amadeo, Cavite were collected especially during the non-bearing and flowering months of coffee trees and examined in the laboratory for presence of the pest.

The feeding response was also noted by introducing adults into the pods of plant species for 48 hours.

Population Build-up in Storage — Three kg. of field collected berries were placed inside each of the three cages. The initial infestation was noted before storage and two hundred berries were taken weekly for six weeks to determine the increase of infestation.

B. Incidence of the Coffee Berry Borer

Two municipalites were surveyed in Laguna and three each in Quezon, Batangas and Cavite. In Oriental Mindoro, two collection trips were made in 1976-77 in three towns while only one in Mt. Province.

The collection surveys were made when the berries were mature which varied from one place to another.

The sample collection was limited to certain areas that were accessible by the vehicle and to those owned by farmers willing to sell or donate the berries. The number of farmers surveyed varied from one place to another, and from year to year, ranging from 9 to 75 farmers.

At least 200 berries were randomly collected from at least twenty trees per farmer. The more fruit bearing trees in an area, the more berries were collected. In Laguna, Batangas and Cavite more farmers were surveyed than in the other provinces.

The collected berries were examined for the distinctive entry holes of coffee berry borer and the per cent damaged and undamaged berries were noted.

RESULTS AND DISCUSSION

A. Biology of the Coffee Berry Borer

Life History — The life cycle of the coffee berry borer range from 26 to 36 days (Table 1). The developmental period and longevity of the male is shorter than the female.

Table 1. Life history[a] of coffee berry borer.

Stages	Duration (Days)	
	Range	Mean
Egg	4 - 9	4.86 ± .19
Larval Stages	19 - 31	23.49 ± .68
Pupa	4 - 10	8.72 ± .23
Adult		
Male	15 - 40	25.83 ± .96
Female	26 - 70	41.60 ± .57
Total		
Male	42 - 90	66.2 ± .47
Female	53 - 120	86.5 ± .52

[a]Based on 80 individual observations.

The fertile female bores into the coffee berry through the fleshy pericarp and make a tunnel in the bean where the eggs are deposited. The female usually lay its eggs first 3 to 4 days after emergence with an average of 2 eggs per day. It has two larval instars with a total larval stadia of 19 to 31 days. Generally, the larvae of the future female feeds longer than that of the future male.

The longevity of male in capacity ranges from 19 to 40 days and the female ranges from 26 to 70 days. In the field, the longest recorded longevity of a female is 282 days with an average of 156 days which is sufficient to enable the insect to carry over from one crop to the next (Hargreaves 1926).

The life cycle of the borer in the Philippines is longer than what is recorded for the borer in Uganda which is 37 to 41 days for the male and 60 to 62 days for the female (Hargreaves 1926).

Description of the Different Stages. The different stages of the borer is shown in Fig. 1.

a. *Egg* — The egg is translucent white, 0.60 mm. long 0.30 cm at the middle with one and more sharply rounded than the other.

b. *Larva* — The larva is a creamy white, footless grub with a pale brown head; hairs are sparsely scattered over the body and head. The length and

Fig. 1. The different stages of the coffee berry borer.
a - egg
b - larva
c - pupa
d - adult

Fig. 2. Showing the circular hole in or near the small depression at the tip where the female enters the berry.

Fig. 3. Interior of the opened berries appearing hollow due to feeding (A) of the larva and adult stages. (B) An enlargement of a portion of the damage showing the egg and larva of the coffee berry borer.

width of the female larva is 1.2 mm and 0.40 mm, while the male is 1.0 mm and 0.42 mm, respectively.

c. *Pupa* — The pupa is creamy white at first and later becomes pale brown.The male is 1.01 mm to 0.01 mm and the female is 1.55 to 0.02 in length. The width of the former is 0.42 + 0.05 mm and of the latter 0.63 ± 0.01 mm.

d. *Adult* — Like the pupa, the adult male and female differ in size, the former is 1.3 — ± 0.01 mm while the female is 1.48 ± 0.02 mm in length.

Just upon emergence the subcylindrical beetle is soft and pale brown which gradually changed to black within five days. The head is small and subventrally inserted into the prothorax; and is consequently not always seen in the dorsal view of the beetle. The gently rounded prothorax is dull black with minute pits and tubercles. The wing covers are black and somewhat shiny in appearance, each with eleven slight longitudinal ridges clothed with linear series of regular hairs which alternate with the finer hairs of the minutely pitted furrows. The body, legs, wing covers and antennae are sparsely covered with fine, brown short hairs. The short, clubbed, elbowed and segmented antennae and the legs are pale brown. The male resembles the female except in size and vestigial hind wings.

Habits of the adult

The female beetle almost invariably enters the berry through a circular hole in or near the small depression at the tip (Fig. 2) where the calyx of the flower used to be. It is seldom that the insect enters through the sides or basal portions of the fruits. The borer remains in a single berry until all the food is exhausted before it flies to another berry.

The borer breeds on mature fruits and black overripe berries. Since the male has a small or vestigial hindwings, fertilization must take place in the berry where the male developed. The male has been found to secrete the sex hormones which enable the female borer to locate the former. Dissection of newly bored berries showed that females are never accompanied by males.

The females are more numerous than males, the average ratio was ten to one. The ratio may vary from 5:1 to 20:1 in the present study. Leefmans (1930) reported a ratio of 500:1 to 20:1, with an average of 60 females to 1 male. Bergamin (1943) reported that one male can fertilize up to 30 females.

The generation in the field seems to overlap and all stages of the pest were found at any one time. This is because food is available throughout the year. In most places in Luzon, the ripening of the berries are not uniform and the farmers tend to leave young berries in coffee trees before the next fruit-bearing season. Besides, they feed on some pods of shade trees present in the plantation such as *Leucaenea leucocephala*.

The beetles have been observed to be in flight in the field from 3:00 p.m. and reached a considerable number at 4:00 to 5:00 p.m. from infested trees.

Nature of Damage. The larva and adult berry borer directly damage coffee by feeding on the tissues of the beans. This insect lives and breeds

in the bean. The whole of the bean may be destroyed or the bean may be so extensively damaged as to render it valueless. The adult seldom attack another bean until the contents of the first bean has been consumed.

Another type of damage due to the borer is the falling of young beans and/or production of rotten beans. When the female departs from a green berry into which it has bored, a rot sets in and the damaged bean decays. After pulping such beans float in the water. When the borer infestaiton is extensive this type of damage becomes very serious.

The characteristic symptoms of the damage is the presence of one to several holes at the tip (Fig. 2). When opened, the interior of the ripe berries appear hollowed due to the feeding of the larva and adult stages (Figs. 3A and B).

It was noted as shown by the incidence data that the degree of borer infestation at a particular time vary greatly in different coffee-growing areas. During severe infestation which is periodic in occurrence, as many as 80.97% of the berries showed evidence of borer attack.

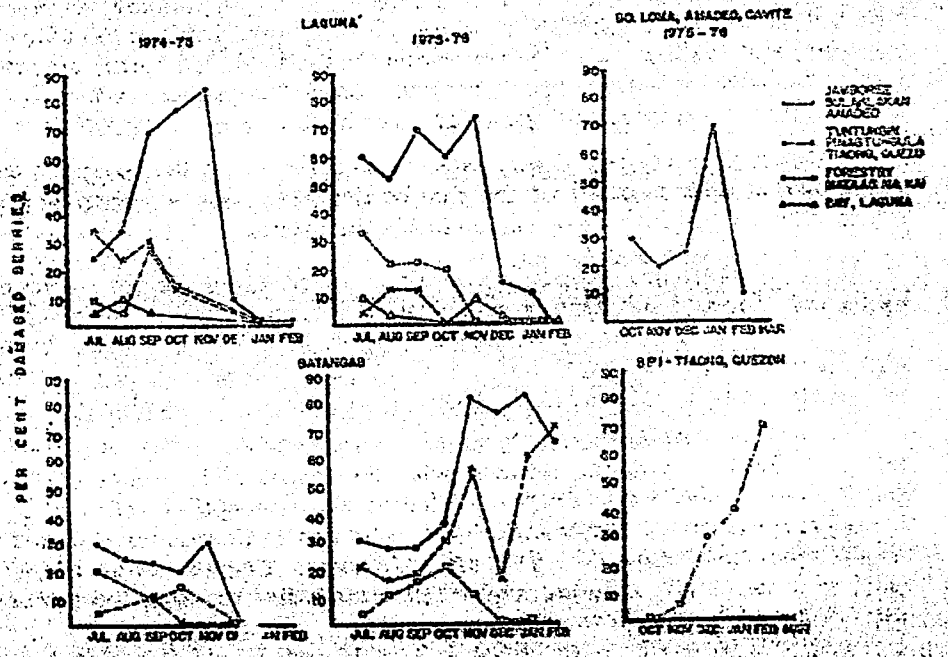

Fig. 4. The monthly infestation of coffee berries by coffee berry borer in selected areas of Batangas, Laguna (1974-1976), Cavite and Tiaong, Quezon (1976).

Seasonal Abundance. The monthly infestation of coffee berry borer in selected areas of Laguna and Batangas from 1974 to 1976 are presented in Fig. 4.

In all areas, the peak of infestation conicided with the maturity and ripening of the berries and decline considerably during and after the harvesting period. In Laguna, the pest was relatively most abundant from September to November; in Batangas, November to January; in Cavite, January; and in Quezon in February. No new berries were available from March to June. There seemed to be an increased in the infestation in Batangas especially in Bulaklakan and Pinagtungulan, Lipa City in 1976. Tiaong and Cavite, which were free from pest in 1972 were noted to have 75% infestation in October 1975. The farmers attributed the occurrence to the transport of coffee beans in sacks to Batangas and transporting back the empty sacks for re-use in Cavite.

Two unidentified hymenopterous parasites belonging to Braconidae and Exyntidae were found parasitizing the larva of *H. hampei.*

Color Preference. The response of the adult coffee berry borer to colored papers representing the different stages of the coffee berries was studied. The order of preference in decreasing order was: white red yellow green black orange. The Indian Coffee Board (1969-1970) similarly reported that the females of this species are attracted to colored lights in the following oder: red yellow blue green violet. In the field, ripe berries are preferably bored by the borer than the green ones. The preference for red is unusual, since most insects are generally color blind to red.

Probably they are not guided only to the berries by the color but by other factors such as odors of the ripe berries and of the sex pheromones secreted by the males which would be inside the berries.

Varietal Preference. Robusta was the most preferred variety followed by Excelsa, Liberica and Arabica in decreasing order as shown by the percent damaged beans and number of insects present in the sample beans from Lipa, Batangas and Tiaong, Quezon (Fig. 5). The infestation in all the varieties except Arabica increased as the beans ripen (January to March).

Our results agree with the report of Leroy (1936) in Congo and Frejederiche (1924) in Java but disagree with the report of Le Felley (1968) and Chevalier (1947) that *Coffea arabica* is most susceptible followed by *C. canephora* (Robusta coffee) with *C. excelsa* and *C. liberica* less attacked. On the other hand, Roepke (1915) reported that *C. liberica* and the species allied to it are chiefly attacked, and when there is an increase in infestation the varieties of *C. canephora* suffer.

It seems that the relative susceptibility can be different in different places due to differences in conditions of growth. Tothill (1940) reported that

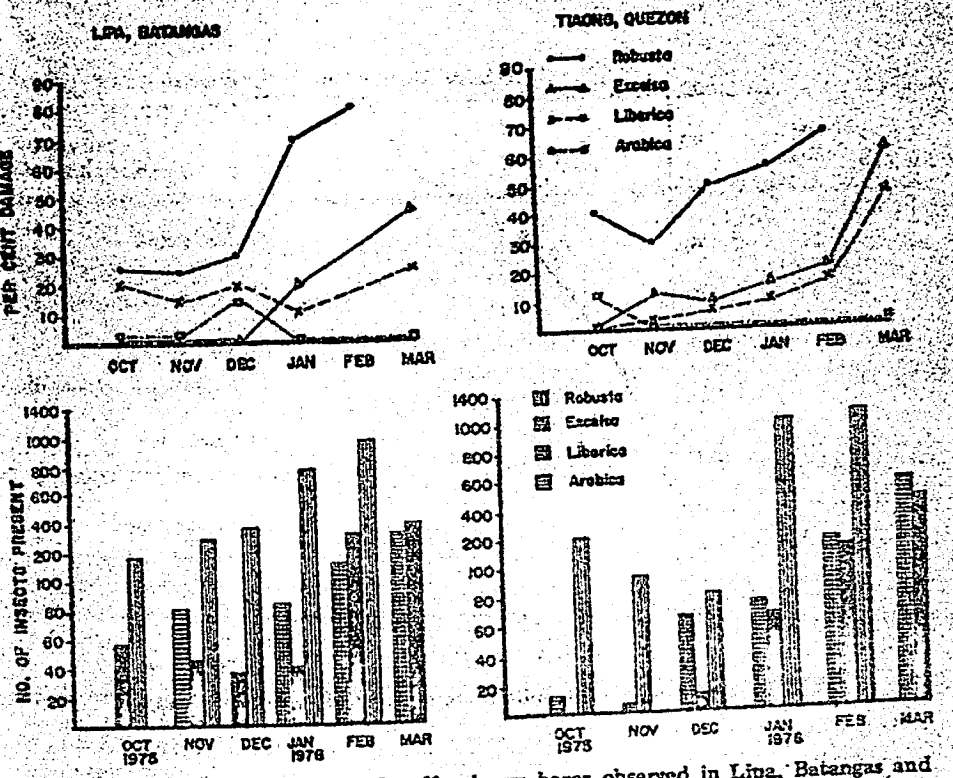

Fig. 5. Varietal preference of coffee berry borer observed in Lipa, Batangas and Tiaong, Quezon.

H. hampei is usually abundant in wetter forests, a condition where Robusta thrives well in Uganda.

The fruit bearing months of the different varieties overlap each other and thus contribute to the rapid population growth of the pest. In Lipa, Batangas and Tiaong, Quezon (BPI stations) where all the four varieties are present in one area, the infestation increased rapidly than in Amadeo, Cavite, where coffee trees are mainly Robusta. Besides, control of the pest can easily be programmed and regulated in the former town because of th uniform fruiting and harvesting as compared to the latter.

Rate of Population Build-up in Storage. Figure 6 showed that an initial infestation of 20% of newly harvested berries could increase to 100% after six weeks of storage. This indicate the need of fumigating or soaking the seeds in boiling water before drying and storage.

Alternate Hosts. Eggs, larvae and pupae were found on ipil-ipil (*Leucaena leucocephala*), madre de cacao (*Gliricidia sepium*), tagpo (*Psychotia luzonensis*), patani (*P. launatus*) (wild type) and pakit (*Discorea luzonensis*)

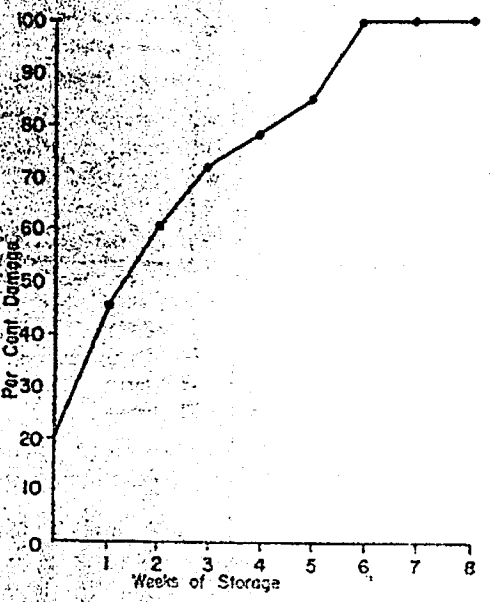

Fig. 6. Rate of population build up of coffee berry borer in storage.

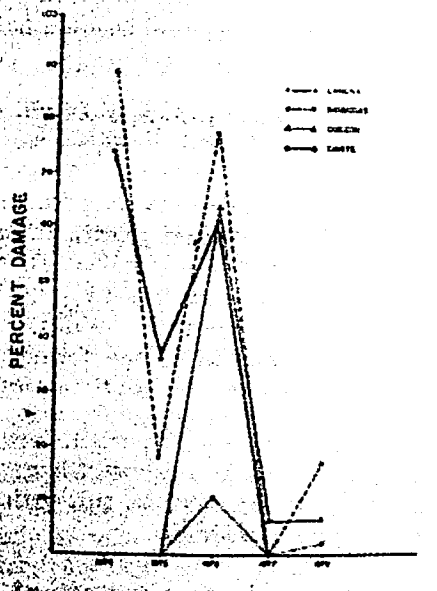

Fig. 7. Incidence coffee berry borer infestation in selected coffee growing areas in Luzon, Tagalog.

TABLE 2. Host plants tested for feeding in the laboratory[a].

Family and Scientific Name	Mean Days of feeding
Caesalpinaceae	
Cassia occidentalis L.	14.83
Caesalphinia pulcherrima (L.) Sw.	13.10
Capparidaceae	
Cleome rutidosperma DC.	1980
Convolvulaceae	
Operculina turpethum (L.) Manso	11.25
Mimosaceae	
Acacia rugata (Lam.) Ham.	9.23
Leucaena leucocephala (Lam.) de Wit	14.95
Mimosa pudica L.	4.70
Papillionaceae	
Gliricidia sepium (Jacq.) Kunth ex Walp	18.45
Phaseolus lunatus L.	16.10
Crotolaria juncea L.	12.13
Abrus precatorius L.	13.60
Calopogonium mucunoides	14.33
Centrosema pubescens Benth	11.75
Pueraria phaseoloides (Roxb.) Benth	10.00
Passifloraceae	
Passiflora foetida Linn.	13.10
Rosaceae	
Rubus rossaeflotus Sm.	11.60
Rubiaceae	
Ixora sp.	10.70
Psychotia luconiensis (Cham & Schl.) F. Vill.	14.96
Solanaceae	
Solanum nigrum L.	8.16
S. ferox L.	6.00
S. biflorum L.	11.61
S. seaforthianum Andr.	7.00

[a]Identified by Mrs. Norma Aguilar.
[b]Average of 3 replicates.

seeds collected from Batangas and Cavite. Collection of other plants listed in Table 2 were extensively made during the non-bearing months of coffee

in Laguna, Batangas, Cavite and Quezon but no coffee berry borer was noted.

The adult laboratory feeding experiments on different host plants (Table 2) showed that the adult fed in all these species but longest in *Calopogonium* followed by *Ixora* sp., *P. lunatus*, *P. luzonensis* and *L. leucocephala*. The longevity was also longer in these five species than the other plants tested.

Some of the plants tested were also reported by Le Pelley (1968) to be fed upon by the borer. In addition, he also reported that the borer has been found feeding on pods of *Tephrosia*, *Crotolaria*, *Dialium*, *Caesalpinia;* seeds of *Hibiscus*, *Rubus* and some Leguminosae and also bored on the berries of *Vitis lanseolaria* and *Ligustrum pubinerve*.

Most of the plants tested in the present study were observed to have pods from March to July where there were no more coffee berries available in the field. Dissection of collected pods (*Calopogonium P. lunatus*, and *Ixora* sp.) only showed feeding punctures but no larvae, pupae or adults. Likewise, no adult emergence or egg laying of the adults exposed to these hosts was observed. These plants where feeding of insects were observed but no breeding can be considered as occasional food plants which support the adult life of the borer in the absence of coffee berries.

A. Incidence of the Coffee Berry Borer

The coffee berry borer was consistently found in four provinces among the six provinces surveyed from 1974 to 1978 (Fig. 7). The infestation was very high in Batangas and Laguna in 1974 which declined to less than 40% and 20%, respectively in 1975. There was no infestation recorded in Cavite, Quezon, Oriental Mindoro and Baguio in 1974-75. However, in 1976-78, infestation was noted in Cavite and Quezon.

Note that in 1976 there was an increase in infestation in Laguna, Batangas and Quezon but slightly lower than in 1974 which again declined in 1977 and with very slight increase in 1978. The infestation in Cavite was the lowest among the four provinces surveyed.

Table 3 shows the incidence of the pest in the different towns in selected provinces in Luzon. In Laguna, infestation was high in Bay in 1974-75 but lower in 1975-76. The reverse was true in Los Banos. The most infested area in Batangas, Cavite and Quezon was Lipa City, Amadeo and Tiaong, respectively. In San Juan, Batangas, per cent damaged berries was 0 to 0.3% from 1974 to 1977 but in 1978 there was an abrupt increase. Note that in areas where infestation has been recorded before, the level of infestation was low.

TABLE 3. Incidence of coffee berry borer in selected coffee growing areas in Luzon, 1974-1978.

Province and Town	Mean Percent Damaged Berries			
	1974-76[a]	1976-76[b]	1976-77[c]	1977-78[d]
Laguna				
Bay	88	40	3.50	17.50
Los Banos	62.50	82	0.80	5.26
Batangas				
Lipa City	89	72.50	0.69	0
Mataas na Kahoy	0	0	0.05	0
San Juan	0	0	0.03	83.33
Cavite				
Amadeo	0	19.50	0.03	0
Silang	0	3.0	0.02	0
Tagaytay City	0	10.50	0.04	0
Quezon				
Candalaria	0	0	0	0
Dolores	0	0	0.11	0
Tiaong	0	63.50	12.50	23.95
Oriental Mindoro				
Basco	0	0	0	0
Victoria	0	0	0	0
Calapan	0	0	0	0
Mt. Province				
Irisan	0	–	–	–
Baguio	0	–	–	–

[a]Farmers surveyed 3-7 farmers/town with 2000-6500 collected berries/farmer.
[b]Farmers surveyed 3-20 farmers/town with 200-500 collected berries/farmer.
[c]Farmers surveyed 4-25 farmers/town with 500-3000 collected berries/farmer.
[d]Farmers surveyed 2-10 farmers/town with 300-500 collected berries/farmer.

This could be attributed to the farmer's realization of the problem that they practiced certain measures to control the pest such as harvesting the berries immediately as they ripen, collecting all the berries from the trees and chemical control.

CONCLUSION

The availability of coffee berries almost throughout the year in Luzon due to the varying fruit-bearing months and non-uniform maturity of coffee in different towns and provinces, the practice of farmers of leaving some berries in the trees unharvested and the presence of alternate hosts are very favorable for the rapid build-up and distribution of *H. hampei* in the region.

Besides, most coffee farms are planted with Robusta and Excelsa which are highly preferred by this pest.

Constant monitoring of the presence of the pests and immediate application of control measures would prevent the outbreak of coffee berry borer which could endanger the coffee industry in the region.

ACKNOWLEDGEMENT

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